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AUTHORITY

USNAL ltr, 18Jan 1972

HEADQUARTERS
U.S. ARMY QUARTERMASTER RESEARCH AND ENGINEERING
FIELD EVALUATION AGENCY
FORT LEE, VIRGINIA

STEFA-CE

26 May 64

SUBJECT: Final Letter Report, Engineering Design Test of Boots, Combat, Leather, DMS, Conventional vs. Special Soling, TECOM USATECOM-8-3-6000-02K

14p.

TO: Commanding General
U.S. Army Natick Laboratories
ATTN: Assistant Deputy Scientific Director
for Engineering
Natick, Massachusetts 01762

1. References: See Appendix A.

2. Authority: USATECOM Project Transcript Sheet, USATECOM Project No. 8-3-6000-02K, 6 June 1963, subject: Boots, Combat, Leather, DMS, Conv. vs. Spec. Soling.

3. Purpose of Test: ~~The purpose of~~ this test ~~was to subject the~~ SUBJECTED THE experimental and poly-blend Buna N sole and heel units to wear for 2000 traversals of the Quartermaster Research and Engineering Field Evaluation Agency's Footwear Testing Course to determine differences in wear resistance of the two types of outsole and heel stocks.

4. Description of Materiel: Two types of DMS leather combat boots were used as test vehicles. The two types of boots were identical except for the stock used in the outsole and heel units. One type utilized a poly-blend Buna N stock and the other an experimental stock in the outsole and heel units.

5. Background: This test of outsole and heel stocks was part of the development and testing program to obtain an optimum outsole and heel stock material for the leather combat boot with a direct molded sole

construction. The stock used in the DMS tropical boot becomes too hard at low temperatures, creating hazardous walking conditions due to the poor traction qualities of the outsole and heel units. Thus, efforts have been directed toward the development of a compound that will not result in undesirable hardness of the outsole and heel under climatic conditions where the all-leather upper combat boot is conventionally worn. Laboratory studies have produced an experimental compound which remains soft at temperatures as low as 0°F., allowing greater retention of traction qualities by outsoles made of this compound. Data are needed, however, as to the wear resistance of this compound when subjected to actual use in outsole and heel units. Leather combat boots incorporating this experimental outsole compound were obtained for wear testing in comparison with boots incorporating the poly-blend Buna N compound in outsole and heel units.

6. Test Objectives: To determine if there is any difference between the wear resistance of the experimental outsole and heel unit and that of the poly-blend Buna N outsole and heel unit.

7. Procedures: This test was initiated at Fort Lee, Virginia, on 15 July 1963, utilizing enlisted personnel of the Field Evaluation Agency. Each of 14 test participants was issued one pair of boots, cross-mated with the experimental compound used in the outsole and heel unit of one member and the poly-blend Buna N compound used in the outsole and heel unit of the other member, with equal distribution as to left and right members of each of the two types.

Prior to test wear each boot was inspected for manufacturing defects and variations and code-marked for cont[illegible] and identification purposes. The boots with the experimental compound outsole and heel unit were code-marked and hereinafter referred to as Type E; those with the poly-blend Buna N compound outsole and heel unit were code-marked and hereinafter referred to as Type S.

Also prior to wear, measurements were made of the physical characteristics of each boot, including weight, hardness of the outsole compound at three specific locations, the outsole and heel cleat depths, and the heel thickness at various locations as shown in the template in

Appendix B. These measurements were made for comparison with measurements made at the completion of test wear; differences in cleat depth and heel thickness measurements, to be used to determine differences in wear resistance between the two types of outsole and heel units.

Each of the 14 test participants wore his assigned pair of cross-mated boots while completing 2000 traversals of the Agency's Footwear Testing Course. Each boot was inspected daily for evidence of failures and wear conditions. The outsole and heel cleat depth and heel thickness were measured at the specific locations shown in Appendix B after each 500 traversals. Weight and outsole hardness measurements were made at the time of withdrawal from test wear, i.e., after 2000 traversals of the Footwear Testing Course.

8. Results and Discussion:

Six individual Type S and 4 individual Type E boots had minor defects prior to use. These defects consisted of slight depressions in one or more cleats of each boot as shown in the photograph in Appendix C(1). None of the defects was considered of sufficient degree as to affect test wear and no boots were withdrawn from the test sample. These defects had no appreciable effect on the test wear of the boots.

The average weight of the 14 Type S boots before wear was 853 grams, ranging from 840 to 865 grams. The average weight of the 14 Type E boots was 860 grams, ranging from 840 to 870 grams. The boot weights after wear were: Type S, average 818 grams, ranging from 775 to 844 grams; and the Type E, average 830 grams, ranging from 811 to 845 grams. Weights of the 14 individual boots of each type before and after wear are shown in Appendix D.

Hardness measurements, taken with a Shore "A-2" durometer, at the centers of the toe, shank, and heel areas of each boot prior to wear showed consistency of hardness. The overall average hardness reading for both the 14 Type S and 14 Type E boots was 65. Hardness measurements taken at each of the same three locations for each boot after wear showed no appreciable change. The overall average hardness reading for the Type S boots was 65, while that of the Type E boots was 64. Hardness readings are shown in Appendix E.

Differences of .006 inch or less were found between boot types in the average measurements of cleat depths at any of the 8 locations on the outsole and the 5 locations on the heel, and .08 inch or less between the measurements of the heel thickness at 3 locations when the boots were measured prior to wear. The average measurements at each location, identified in the template in Appendix B, as obtained prior to wear and after each 500 traversals are shown in Table I. At each location the average total amount and total percent of material worn away was greater on the outsoles and heels of the Type S boots than on the Type E boots.

A comparison of the location of the point of greatest wear, i.e., areas exhibiting the greatest amount of material worn away on each boot with that of its mate, is shown in Table II. These comparisons show that more material was worn away from the Type S boots in the outsole cleats, in the heel cleats, and in the heel thickness than in the Type E boots.

Five of the Type E boots incurred partial outsole and upper bond separations at the toe area during test wear, as shown in the photographs in Appendix C(1). These separations were approximately 1/2 inch in length when first observed and increased, with one exception, to 1 to 1 1/2 inches prior to the completion of the 2000 traversals. One separation did not increase in length. The separations first were evident after 700 to 900 traversals.

The boots of both types incurred chipping away of the outsole and heel cleats as shown in the photographs in Appendix C(2). In most instances the outsole chipping occurred in the small cleats located medially to the large cleats along the outsole edge. These small cleats are designated 9a through 27a on the template in Appendix B. The chipping of the heel cleats occurred on the medial edge of the 3 forward cleats on the inner heel and the 2 forward cleats on the outer heel, designated cleat Numbers 33, 34 and 35, and Numbers 42 and 41, respectively in Appendix B. The frequency of chipping of outsole and heel cleats at specific locations in each boot type is shown in Table III.

TABLE I

AVERAGE MEASUREMENTS OF OUTSOLE AND HEEL CLEAT DEPTH AND HEEL THICKNESS AT SPECIFIC LOCATIONS AS SHOWN IN APPENDIX B AS OBTAINED PRIOR TO WEAR AND AFTER EACH 500 TRAVERSALS OF WEAR OF 14 BOOTS OF EACH TYPE

Area Of Measurement	Specific Location Of Measure	Unit Of Measure	Type S							Type E						
			Average Measurements					Average Total Loss		Average Measurements					Average Total Loss	
			Prior To Wear	After 500 Trav	After 1000 Trav	After 1500 Trav	After 2000 Trav	Amount	Percent	Prior To Wear	After 500 Trav	After 1000 Trav	After 1500 Trav	After 2000 Trav	Amount	Percent
Outsole	A	1/1000 Inch	305	269	248	229	215	90	30	301	280	263	250	232	69	
	B		325	258	222	196	167	158	49	331	274	248	227	203	128	39
	C		309	278	258	241	222	87	28	305	283	273	260	245	60	20
	D		316	278	256	239	218	98	31	316	282	269	256	240	76	24
	E		320	250	215	199	164	156	49	319	264	241	217	191	128	40
	F		342	302	272	249	226	116	34	344	3[illegible]	305	289	270	74	22
	G		332	309	290	272	252	80	24	332	322	309	297	280	52	16
	H		341	328	317	305	294	47	14	342	334	326	318	306	36	11
Heel	1		333	299	279	259	235	98	29	333	314	300	283	266	67	20
	2		330	290	269	237	206	124	38	329	298	280	261	238	91	28
	3		168	132	104	81	57	111	66	170	144	123	106	89	81	48
	4		330	315	300	286	270	60	18	333	320	311	301	291	42	13
	5		332	316	303	289	274	58	17	336	325	317	307	298	38	11
	6	Inches	1.44	1.32	1.22	1.16	1.11	0.33	23	1.36	1.28	1.21	1.15	1.09	0.27	20
	7		1.43	1.25	1.17	1.10	1.04	0.39	27	1.37	1.25	1.17	1.11	1.04	0.33	24
	8		1.43	1.32	1.26	1.21	1.17	0.26	18	1.37	1.30	1.24	1.19	1.15	0.22	16

TABLE II

COMPARISON OF MEASUREMENTS OF POINTS OF MAXIMUM WEAR ON EACH MEMBER AND ITS MATE IN THE 14 INDIVIDUAL PAIRS OF TEST BOOTS
(Locations as Identified in Template in Appendix B)

	Outsole Cleat Locations (A-G) Measurements In 1/1000 Inch					Heel Cleat Locations (1-5) Measurements In 1/1000 Inch					Heel Thickness Locations (6-8) Measurements In 1/16 Inch				
	Type S		Type E		Diff Between	Type S		Type E		Diff Between	Type S		Type E		Diff Between
Pair No.	Location Of Max. Wear	Total Amount Worn Away	Location Of Max. Wear	Total Amount Worn Away	Type S And Type E	Location Of Max. Wear	Total Amount Worn Away	Location Of Max. Wear	Total Amount Worn Away	Type S And Type E	Location Of Max. Wear	Total Amount Worn Away	Location Of Max. Wear	Total Amount Worn Away	Type S And Type E
1	B	212	B	159	53	2	157	2	116	41	7	8	7	6	2
2	B	156	E	131	25	2	111	2	116	-5	7	6	7	6	0
3	B	127	E	113	14	3	66	3	80	-14	7	5	7	5	0
4	E	160	E	163	-3	2	79	2	93	-14	7	4	7	4	0
5	E	120	E	120	0	2	129	3	137	-8	7	6	7	6	0
6	E	175	E	142	33	2	107	2	62	45	7	7	7	5	2
7	D	169	E	118	51	2	100	2	104	-4	7	6	7	6	0
8	E	184	E	143	41	2	170	2	126	44	6	7	6	7	0
9	B	182	B	119	63	2	126	2	78	48	7	7	7	5	2
10	B	205	B	155	50	2	143	3	90	53	7	7	7	5	2
11	B	220	B	163	57	2	222	2	128	94	7	7	6	6	1
12	B	154	E	110	44	2	127	2	56	71	7	7	7	5	2
13	B	165	B	114	51	2	111	2	73	38	7	5	7	4	1
14	B	178	E	129	49	2	91	2	50	41	7	5	7	5	0
Avg. Loss[a]		171.9		134.2	37.7		124.2		93.5	30.7		6.2		5.4	0.8

[a]Difference in amounts worn away significant at the 5 percent probability level for outsole cleats, heel cleats, and heel thickness.

TABLE III

FREQUENCY OF OUTSOLE AND HEEL CLEAT CHIPPING AT SPECIFIC LOCATIONS ON EACH BOOT TYPE

(Locations as Identified in Template in Appendix B)

Outsole Cleats			Heel Cleats		
Location	E	S	Location	E	S
9a	2	1	33	3	8
10a	2	0	34	5	9
11a	2	0	35	4	9
12a	2	1	41	2	3
13a	1	0	42	0	4
15a	0	1	Total	14	33
16	0	2			
16a	1	1			
17	0	1			
17a	1	1			
18a	2	1			
19	0	1			
19a	2	3			
20	0	1			
20a	1	1			
21	0	2			
21a	1	2			
22	0	2			
22a	2	2			
23	1	0			
23a	3	2			
24	1	1			
24a	4	0			
25a	3	1			
26	0	1			
26a	2	3			
27a	0	3			
28	2	1			
29	1	1			
30	3	2			
31	0	1			
32	1	0			
Total	40	39			

STEFA-CE 26 May 1964

SUBJECT: Final Letter Report, Engineering Design Test of Boots, Combat, Leather, DMS, Conventional vs. Special Soling, TECOM 8-3-6000-02K

9. Conclusions: It is concluded that:

a. The wear resistance of the experimental outsole and heel unit is significantly greater than that of the poly-blend Buna outsole and heel unit.

b. Safety statement as required by AMC Regulation No. 385-12 dated 21 December 1962, "Verification of Safety of Materiel from Development Through Testing and Supply Disposition," is as follows: Research, development and testing to date have demonstrated nothing to contraindicate wear or use of subject item by test personnel from a safety standpoint.

10. Recommendations: None.

Howard W. Hembree

HOWARD W. HEMBREE, Ph.D.
Scientific Director

J. E. Bledsoe for
Lt Col QMC

CARL E. BLEDSOE
Colonel, QMC
Commanding

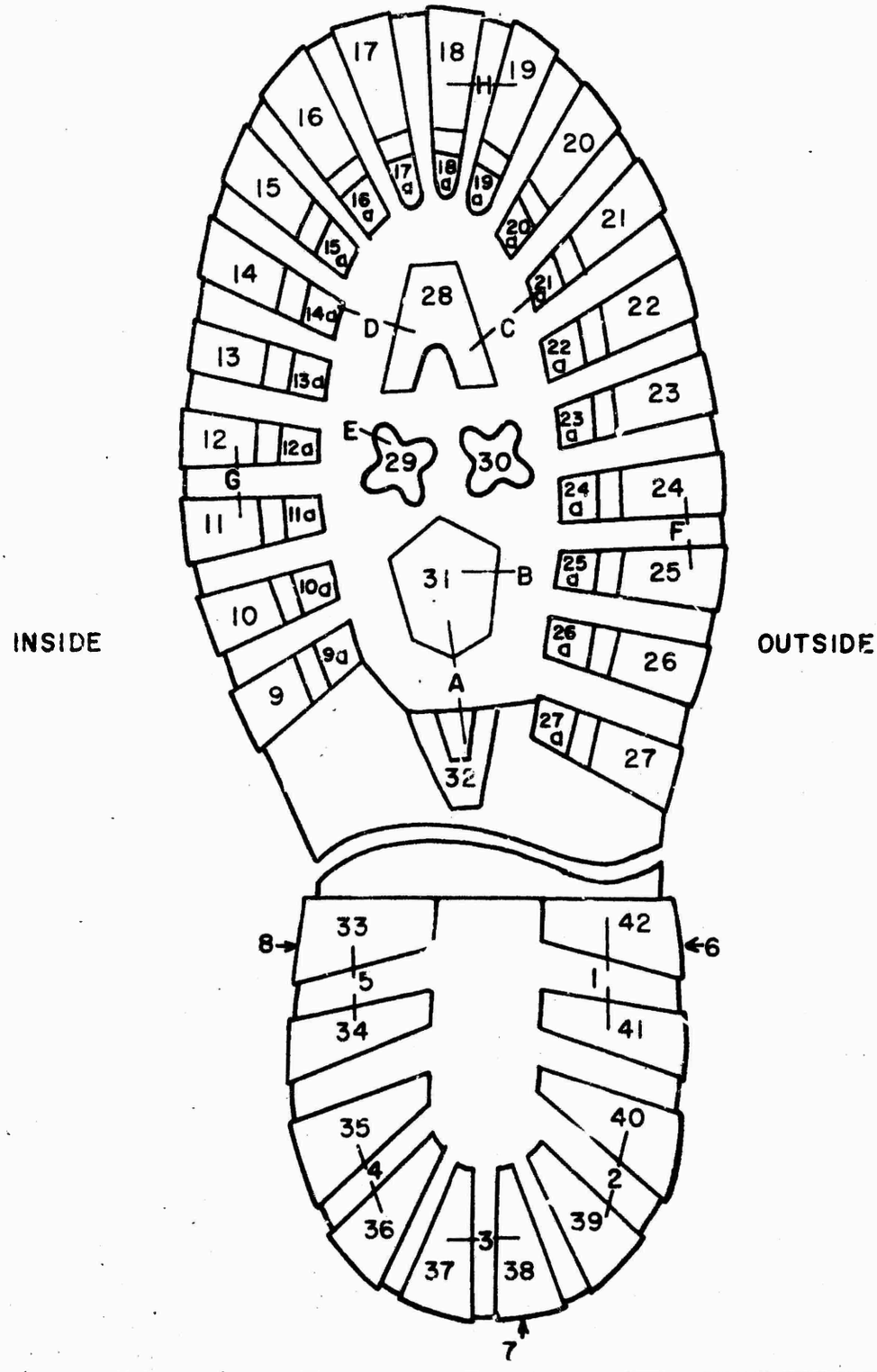
5 Incl
Appendices A-E

References.

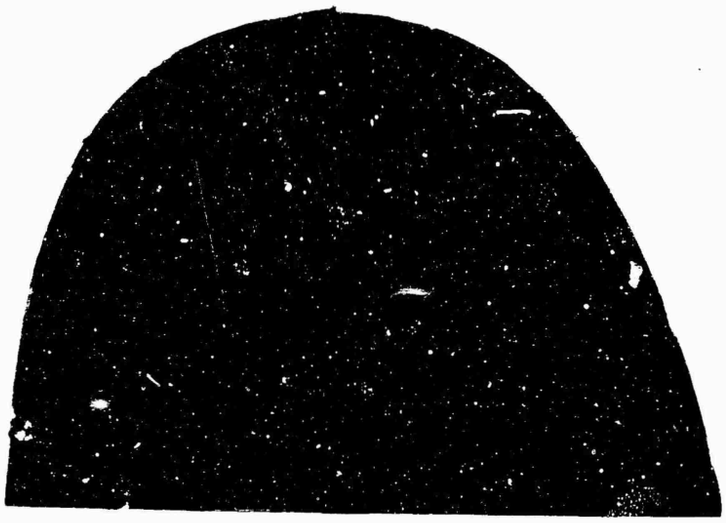
1. Letter, U.S. Army Natick Laboratories, Natick, Massachusetts, 31 July 1963, subject: Amendment to Letter QMREC, AMXRE-COP, 31 May 1963, subject: USATECOM Project No. 8-3-6000-02K, Wear Resistance of Sole and Heel Stock, Boot, Combat, Leather, DMS, and 1st Indorsement, Headquarters, United States Army Test and Evaluation Command, Aberdeen Proving Ground, Maryland, 2 August 1963.

2. Quartermaster Research and Engineering Field Evaluation Agency Final Letter Report of "Test of Sole and Heel Stock, Direct Molded Sole Boots, FEA 61056," 22 August 1961.

OUTSOLE AND HEEL SURFACE TEMPLATE



DEFECTS PRIOR TO WEAR AND FAILURES INCURRED DURING TEST WEAR



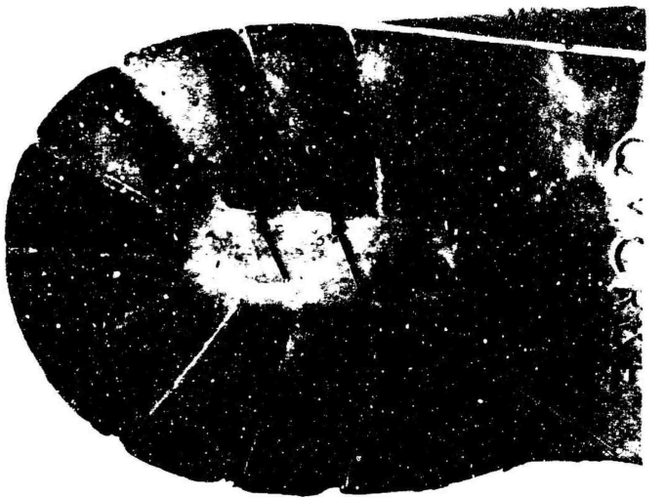
Slight Depressions in Cleat Surfaces of Both Boot Types Prior to Wear.

Outsole - Upper Bond Separation at the Toe of the Type E Boots.

UNITED STATES ARMY
QM R&E
FIELD EVALUATION
AGENCY
FORT LEE, VIRGINIA
TEST TECOM 8-3-6000-02K

NEGATIVE 19, 20

APPENDIX C (1)



Chipping Away of Medial Edge of Heel Cleats.

Chipping Away of Outsole Cleats.

UNITED STATES ARMY
QM R&E
FIELD EVALUATION
AGENCY
FORT LEE, VIRGINIA
TEST TECOM 8-3-6000-02K

NEGATIVE 5, 4

APPENDIX C (2)

WEIGHTS OF INDIVIDUAL BOOTS BEFORE AND AFTER WEAR

(Weights In Grams)

Boot Code No.	Code S Weights		Code E Weights	
	Before Wear	After Wear	Before Wear	After Wear
1	845	'95	855	819
2	860	832	860	824
3	865	843	865	838
4	855	829	870	845
5	850	817	840	811
6	840	79[illegible]	870	832
7	855	830	860	830
8	860	844	855	842
9	840	800	865	832
10	855	814	870	839
11	840	775	870	825
12	860	829	850	837
13	860	825	850	825
14	850	815	855	827
Min.	840	775	840	811
Max.	865	844	870	845
Avg.	853	818	860	830

TYPE A-2 SHORE DUROMETER HARDNESS READINGS FOR INDIVIDUAL BOOTS AT THREE LOCATIONS PRIOR TO AND AFTER TEST WEAR

Boot Code No.	MEASUREMENTS[a]								Boot Code No.	MEASUREMENTS[a]							
	Before Wear				After Wear					Before Wear				After Wear			
	Toe	Shank	Heel	Avg.	Toe	Shank	Heel	Avg.		Toe	Shank	Heel	Avg.	Toe	Shank	Heel	Avg.
S1	69	67	67	68	66	65	64	65	E1	67	61	60	63	64	64	60	63
S2	61	63	63	62	61	65	64	63	E2	64	63	63	63	71	65	62	66
S3	70	67	64	67	70	65	62	66	E3	68	65	64	66	65	66	65	65
S4	70	64	64	66	66	64	66	65	E4	65	67	64	65	67	69	64	67
S5	65	65	65	65	69	68	65	67	E5	70	63	63	65	70	65	62	66
S6	64	64	65	64	67	67	68	67	E6	68	62	61	64	66	62	63	64
S7	68	68	67	68	67	67	67	67	E7	66	64	63	64	66	65	63	65
S8	64	68	67	66	64	66	61	64	E8	68	64	63	65	64	63	62	63
S9	65	67	61	64	64	60	60	61	E9	64	61	64	63	64	64	62	63
S10	63	64	65	64	65	65	62	64	E10	69	66	62	66	65	66	62	64
S11	63	63	65	64	68	66	66	67	E11	66	64	61	64	65	65	60	63
S12	64	63	63	63	63	65	61	63	E12	66	64	64	65	65	63	63	64
S13	64	63	63	63	65	66	65	65	E13	66	64	63	64	66	64	63	64
S14	64	64	64	64	68	68	67	68	E14	66	63	64	64	65	65	65	65
Avg.	65	65	65	65	65	65	64	65	Avg.	67	64	63	65	66	65	63	64

[a] Type A-2 durometer hardness reading for steel equals 100.